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EDITORIAL

Cycle Conferences Needed

It is a truism of life that every growing thing, whether a living organism like a tree or a living idea like the principle of cycles, develops from a small beginning. In wending its way laboriously along the pathways of struggling hope and floundering zeal, even as a seedling has opportunity to perish in the starvation of infertile soils or suffocation of a sunless forest floor, an idea has many an opportunity to perish of starvation, want, and neglect. Intellectual box canyons open on every side, usually with little identifying rubble and outwash. Up many a box canyon does an emerging idea thrust its amoeboid-like body, to withdraw and flow up its forward pseudopodium, only to test anew the next easy side canyon. Often the whole idea rushes up intriguing box canyons before halting against its distant end. Were the idea to know the true path from the false, it would save itself infinite quantities of effort and would markedly shorten its time in reaching the lush pastures it seeks so far ahead.

All life and ideas seem to pass through about the same steps or sequence of events beginning with the first recognition of activity. For convenience, these may be designated as stages and merit some consideration as such.

The Recognition Stage. There is no denying that identification of the start of any new line of endeavor is much easier when we trace it backwards from known success to its remote origins. But recognizing the slow beginning of an idea is indeed difficult at the time. One cannot mark the start of such a beginning with certainty. The sorely tried invalid who has watched hopefully for the change for the better suddenly discovers, "I am better now," though for all the World's gifts he cannot name the instant when the change began. Indeed, spring seems to unfold suddenly in front of our eyes, but only because we do not see the slow-motion progress itself.

The able but untutored "layman" often gives body and substance to the initial stages of cycle study. Long before scientists measured with care and understanding the rings of trees and proclaimed them to show cycles, a scholarly immigrant farmer, Jacob Kuechler, published in a frontier German newspaper an analysis of tree rings and weather basically valid even today. It is thus with other cycles. Woodsmen knew of animal cycles before the biologist recognized them. Cattlemen recognized drought cycles before the weatherman did.

This is the recognition state—a few scientists know what many people take for granted. Many principles propounded are sound enough to continue on through succeeding stages.

Whenever the initial recognition obtains results, by that very token it will sooner or later exhaust its store of energy, often long before all the side canyons have been explored. Yet some of the very greatest discoveries in science have been made in the recognition stage. A principle so great as to be over-powering yields early—unless the very great cloud of dependent details hides it from view.

Early Exploration Stage. Development of a few principles and attainment of a few results leads to a surge anew that we may freely identify as the "early exploration stage."

A great exuberance of thought along with spectacular discoveries, and sometimes stratospheric explanations characterize this stage. The initial thought crosses over into other fields and probes for understanding and reasoning. In the cycle field, great phenomena were called upon for explaining the cause of pulsations—cosmic, psychological, physical—all in the wilderness beyond the road terminals of knowledge. Explorers in all fields tend to claim everything in sight and much beyond the horizon also.

Yet some spectacular discoveries hit

the mark so true at the very first try that they can hardly be improved upon in the work that follows. Thus, the very early explorations of sunspots revealed their cyclic nature. The ebb and flow of animal populations has been known for years. That many business events have a cyclic nature is still an established principle. Even in the nineties, an early era in cycle studies, weather and crops were shown to be cyclic.

The exploratory stages very clearly may be divided into initial and active stages. In the active stage, the first attempts at pooling of ideas and information takes form in the shape of conferences for the meeting of minds. In the cycle field, the exploratory stage has had a number of conferences both informal and formal. Among these may be cited two of very great significance.

Mr. Copley Amory, a distinguished patron of science brought together a group of about thirty scientists at his summer home at Matamek on the north shore of the Gulf of St. Lawrence in Quebec during the last week of July, 1931. They gathered to discuss cycles, particularly those influencing fish and land animal populations. This meeting commonly goes by the name of "Matamek Conference on Biological Sciences." Dr. Ellsworth Huntington of Yale University, one of the participants, prepared a report of the conference in collaboration with an editorial committee.

Another exploratory conference of very great significance took place on April 26, 1932 as a symposium of the National Academy of Sciences, Washington, D.C. It dealt with climatic cycles and commonly goes by the name of "Symposium on Climatic Cycles." As in all explorations, without concerted effort at renewal in subsequent years, the initial generation of energy eventually runs out.

Concerted Study Stage. The third stage in scientific effort may be termed the "stage of concerted study." In the early concerted study stage or even late exploration stage, the various disciplines involved get together around their fringes. Sometimes some hardy adventureres having intellectual and scientific imagination break out of the territorial boundaries in the exploration stage and seize knowledge from many fields for use in their own.

We in the cycle field are barely in the early concerted attack stage, if indeed we have more than put a toe into it. Middle-to-late times of the exploration stage may be as far as we have gone. We have the beginning of the concerted attack stage in the Journal of Cycle Research, where many fields, areas, and disciplines may lay their wares out in the bazaar for all to look at and to handle, perhaps even to buy a little to take back home.

Need for a Conference

It seems obvious to me that it is time for an integrated conference on cycles; physical, biological, geological, climatic, or economic. Any conference needs certain things if it is to succeed. For convenience, the chief ones will be listed as, (1) subject, (2) sponsor, (3) operating crew, (4) place, (5) date, (6) participants, and (7) publication of proceedings. These will be discussed in order.

1) The previous conferences dealt with separate phases of cycles—biological cycles as biology or climatic cycles as climatology. This is good, for any work upon cycles in any field must consider the whole discipline. But the principle of cyclic fluctuations crosses many fields, conceivably all fields of knowledge and effort. Hence, the man studying cycles in human blood pressure may find a clue in the work of a physicist studying cycles in the atmosphere with the passing of storms. The subject of our much-need conference may very well be "The Nature of Cycles."

2) A sponsor is surely about the most important single attribute of a conference other than the participants. Perhaps some cycle patron of today will see the important contribution to knowledge that he can make in this way. Since the ultimate goal of cycle study is **scientific forecast**, any organization, public or private, whose operations must consider and especially plan for the future, is a logical candidate for sponsoring a cycle conference.

Having the fortunate backing of a sponsor, the conference needs a site for its settings and deliberations. Because cycles

appear more pronounced as we go poleward, though not necessarily more important, a northern site has many advantages. While many people like to meet in hotel rooms, the success of the Matamek conference suggests strongly the logic of some hide-away in the Northland. Perhaps the Arctic Laboratory at Point Barrow would be good. Maybe we could find a welcome place in a Greenland installation, or in Labrador, Hudson's Bay, Alaska, Yukon. All the possibilities from the Atlantic to the Pacific the Equator to the Pole should be explored for a suitable site—one having the welcome mat out.

4) The time depends upon many factors. Next winter would be a good one for low or middle latitudes, the summer of 1953 for any and all latitudes.

5) Nothing can be done unless someone has been delegated the many tasks attendant upon any conference, such as by a committee of arrangements. There must be a program, quarters, facilities, transportation, and a lot of other things. There must certainly be some central coordinating force—perhaps in the form of a conference chairman. It takes work, but it is worth it.

6) No conference can go without participants, the people who are steeped in their work and enthusiastic in carrying it before others. "Nothing without work" is surely true; so also is "nothing without interest." There are scores of interested cycle students from one end of the continent to the other, there are many additional workers overseas. Every student must be given an opportunity to appear on the program.

7) The final point of any successful conference is the publication of its proceedings. The pages of the Journal of Cycle Research are open to all papers dealing with cycle subjects. It might be possible to publish the proceedings in their entirety as a part of the Journal.

Leonard W. Wing, Editor

PIG IRON PRICES IN THE UNITED STATES

1784–1951

By Alla Malinowski
Staff member, Foundation for the Study of Cycles

PRICES of pig iron in the United States are available by months from January 1784 to date (except for September 1799-May 1800). However, there is no strictly homogeneous series covering the entire period.

Cole[1] provides us with monthly prices at Philadelphia, 1784-1861. Annual averages of these monthly prices are given in Table 1, Cols. A and B.

The Statistical Abstract of 1912[2] supplies us with a series of average annual prices at Philadelphia 1840 and 1850-1912 which overlaps Cole. These values are posted in Table 1, Col. C. Abstracts for 1920,[3] 1948,[4] 1949[5] give prices at Chicago 1888-1948. These values are posted in Table 1, Col. D. The Survey of Current Business[6,7,8] provides us with a composite index from 1913 to date, which however is discontinuous between June and July of 1948 due to the abandonment of the basing point system of pricing. This index is posted in Table 1, Col. E.

These various indexes are charted in Fig. 1.

Details in regard to the source material are given at the end of this paper.

The spliced series of the Foundation for the Study of Cycles, based upon the above prices and indexes, is posted in Table 1, Column F, and plotted in Fig. 2. Logarithms of the spliced series are posted in Column G.

Details in regard to the construction of the spliced series of the Foundation for the Study of Cycles are as follows;

Prices used for the Foundation spliced series, 1784-1855, are Philadelphia prices from Cole.

Prices used, 1855-1907, are Philadelphia prices from the Statistical Abstract of the United States, 1912[2]. For 1855 the prices of the two series are identical.

Prices used 1908-1946 are Chicago prices from the Statistical Abstracts of 1920[3] and 1948[4]. The 1908 price at Chicago was $17.57. This price is 13¢ or .73% less than the price at Philadelphia for the same year, which was $17.70.

The price used for 1947 was the composite price, from Business Statistics, 1951, which is $34.86. This price is 6¢ or .17% more than the Chicago price for the same year.

The prices used for 1948 was the average of the composite prices January-June and $\frac{42.26}{43.26}$ or .97688 of the composite prices July-December. This value was derived on the assumption that the change in the method of pricing was responsible for an increase of $1 in July 1948 over what the prices otherwise would have been.

The prices for 1949, and 1950, and 1951 are the average annual composite prices times the above constant.

On the whole, the differences being so small, it seemed better to keep to actual prices, jumping from series to series, than to make an arithmetically perfect splice of dubious accuracy and create a series of figures with no relation to reality.

To continue the series, new values from the Survey of Current Business as they unfold must of course be multiplied by .97688 in order to be, as nearly as may be, comparable.

The construction of a price index which does not gear into the current price quotations is always unfortunate but in the present instance seems the less of two evils, especially because the corresponding monthly values are readily available on the basis decided upon without any conversions except for the past 3½ years.

The above index has been expressly designed to be of use for cycle analysis.

Source Footnotes

Cole:

Average annual prices computed from individual monthly quotations.

Prices 1784-1791 and 1795 are given in pounds per ton. These were converted on the basis of 1 pound = 20s, 7s 6d=$1. i.e. the value in pounds was multiplied by 20 and divided by 7 1/2, or multiplied by 2.66. The ratio of 7s 6d=$1 was obtained from Cole,[1] page IX. Other prices are given in dollars per ton.

The long ton of 2,240 pounds seems to have been universally employed.

Designation: "Iron pig, Philadelphia," with notes as follows:

1784-1795, unspecified.
1796, Pennsylvania; description changes to unspecified, August-December.
1797-1813, unspecified.
1814-1820, best.
1821, January-July, best; August-December, American.
1822-1823, American.
1824, January-February, best country; March-December, best.
1825-1827, best.
1828-1837, American.
1838, January-August, American; September-December, American foundry,
1839-1849, American foundry.
1850, January-November, American foundry; December, Charcoal foundry No. 1.
1851-1861, Charcoal foundry No. 1.

Data are missing for September 1799-May 1800 but were supplied by interpolation.

Statistical Abstract, 1912

Prices of pig iron in dollars per ton, No. 1 foundry, at Philadelphia, for calendar year.

Statistical Abstract, 1920

Annual average prices of pig iron, calendar years in dollars per long ton (2,240 lbs.), local No. 2, Chicago (at furnace after 1907). Source: The American Iron and Steel Institute, compiled from the Iron Age and other authoritative sources.

Statistical Abstract 1948, 1949

Average annual prices of pig iron, in dollars per long ton (2,240 lbs.), local No. 2, Chicago (at furnace after 1907). Source: Steel, and The Iron Age annual review issues and American Iron and Steel Institute annual report.

Survey of Current Business, 1940 Supplement

Monthly average wholesale prices, pig iron, composite, in dollars per long ton.

Compiled by the American Metal Market. Data represent averages of daily prices of 10 tons of pig iron, distributed as follows (for January 3, 1939); 1 ton each of Bessemer, valley; No. 2 foundry, valley; No. 2 foundry at Philadelphia, at Buffalo, at Cleveland, and at Chicago; 2 tons each of basic, valley, and No. 2 southern foundry, Cincinnati.

Business Statistics, 1951 edition

Wholesale prices of pig iron, composite, in dollars per long ton.

Compiled by the American Metal Market. Data represent averages of daily prices of pig iron, computed from 10 tons distributed as follows; 1 ton each of Bessemer, valley; No. 2 foundry, valley; No. 2 foundry at Philadelphia, at Buffalo, at Cleveland, and at Chicago (No. 2 x foundry prior to 1938 for Philadelphia and Buffalo and, prior to 1930, for Cleveland); 2 tons each of basic, valley, and No. 2 Southern foundry, Cincinnati. Beginning July 1948, the basis of Quotation was changed from basing point to f.o.b. mill or shipping point.

Survey of Current Business, February 1952.

Wholesale prices of pig iron, in dollars per long ton, by months, January-December.

References

. Cole, A. H., Statistical Supplement to Wholesale Commodity Prices in the United States, 1700-1861, Harvard University Press, Cambridge, Massachusetts, 1938.
2. Statistical Abstract of the United States, 1912, p. 786.
3. Statistical Abstract of the United States, 1920, p. 585.
4. Statistical Abstract of the United States, 1948, p. 881.
5. Statistical Abstract of the United States, 1949, p. 977.
6. Survey of Current Business, 1940 supplement, p. 130.
7. Business Statistics, 1951 edition (a supplement to the Survey of Current Business) p. 154.
8. Survey of Current Business, February 1952, p. S-32.

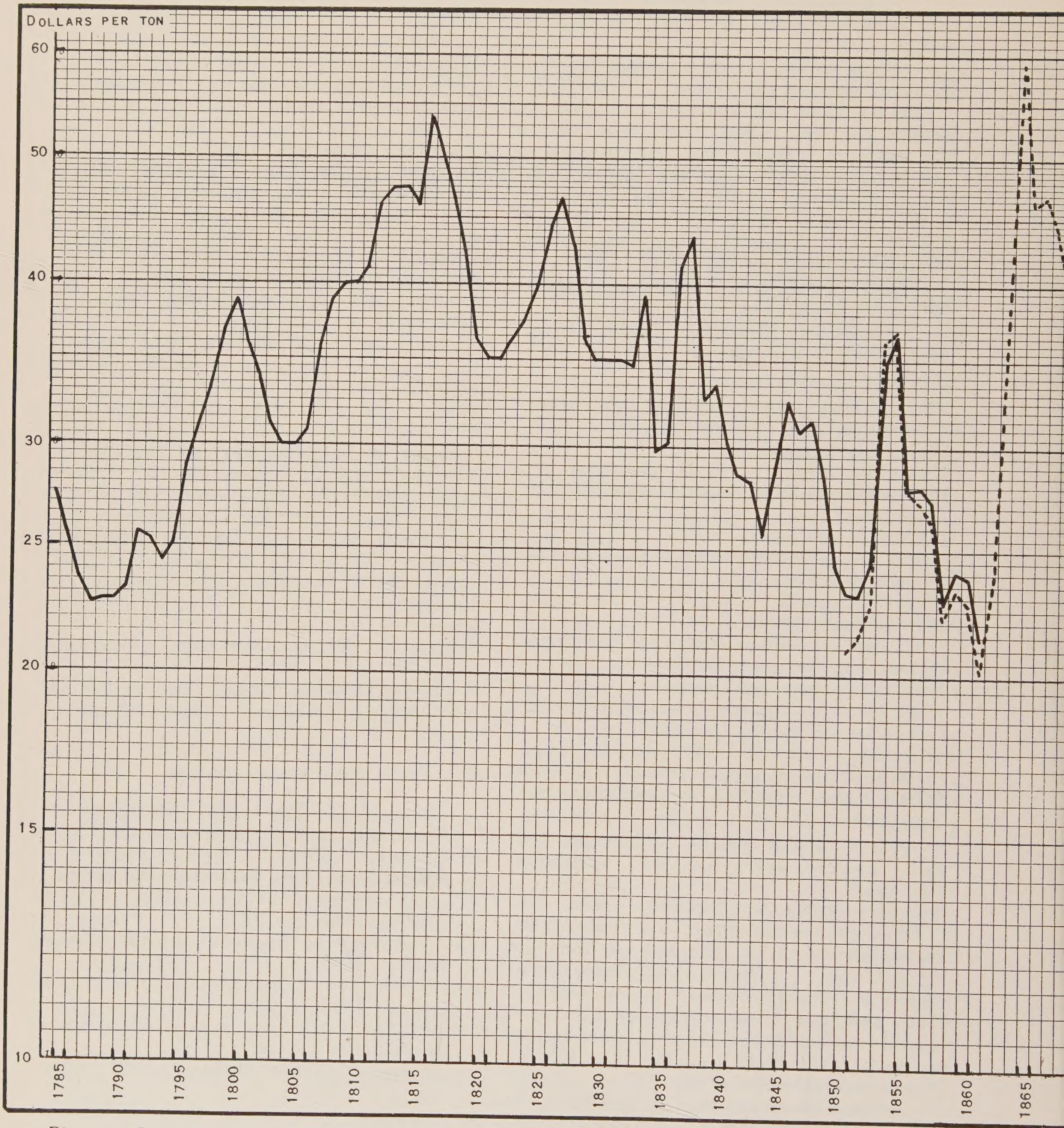
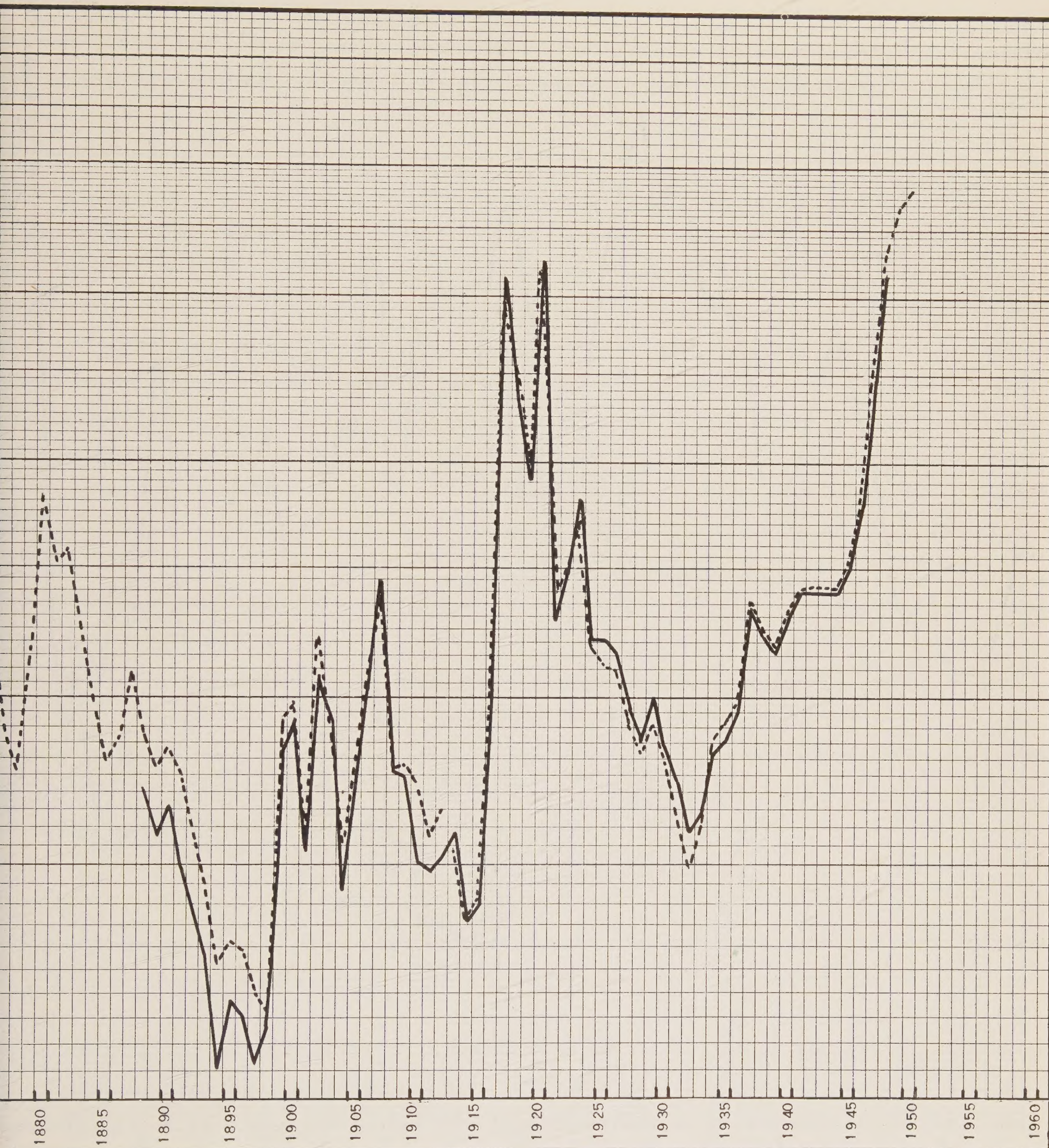


Fig. 1. Pig iron prices, 1784-1951, various sources. See text. Ratio scale.


1880
1885
1890
1895
1900
1905
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1940
1945
1950
1955
1960

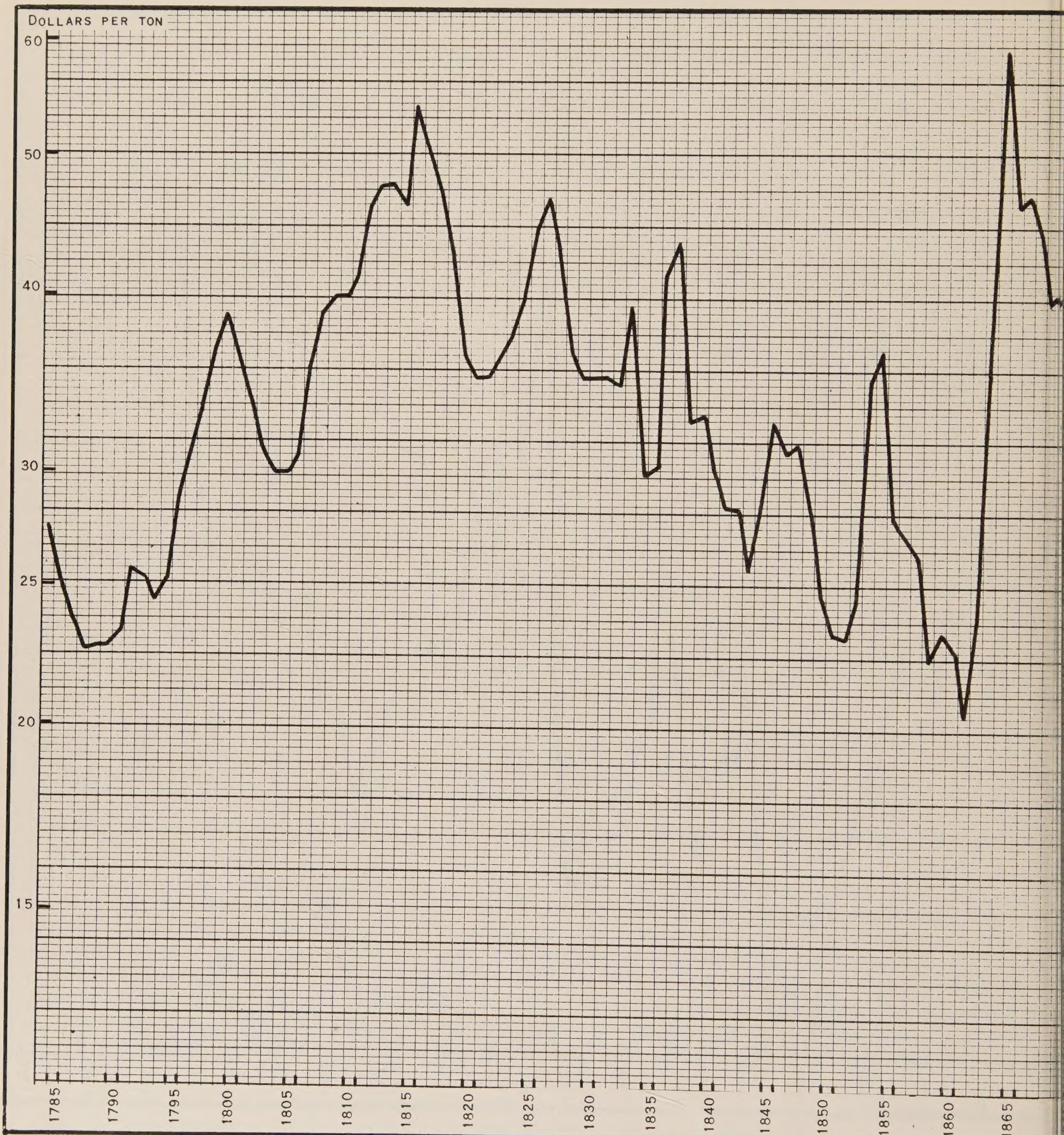
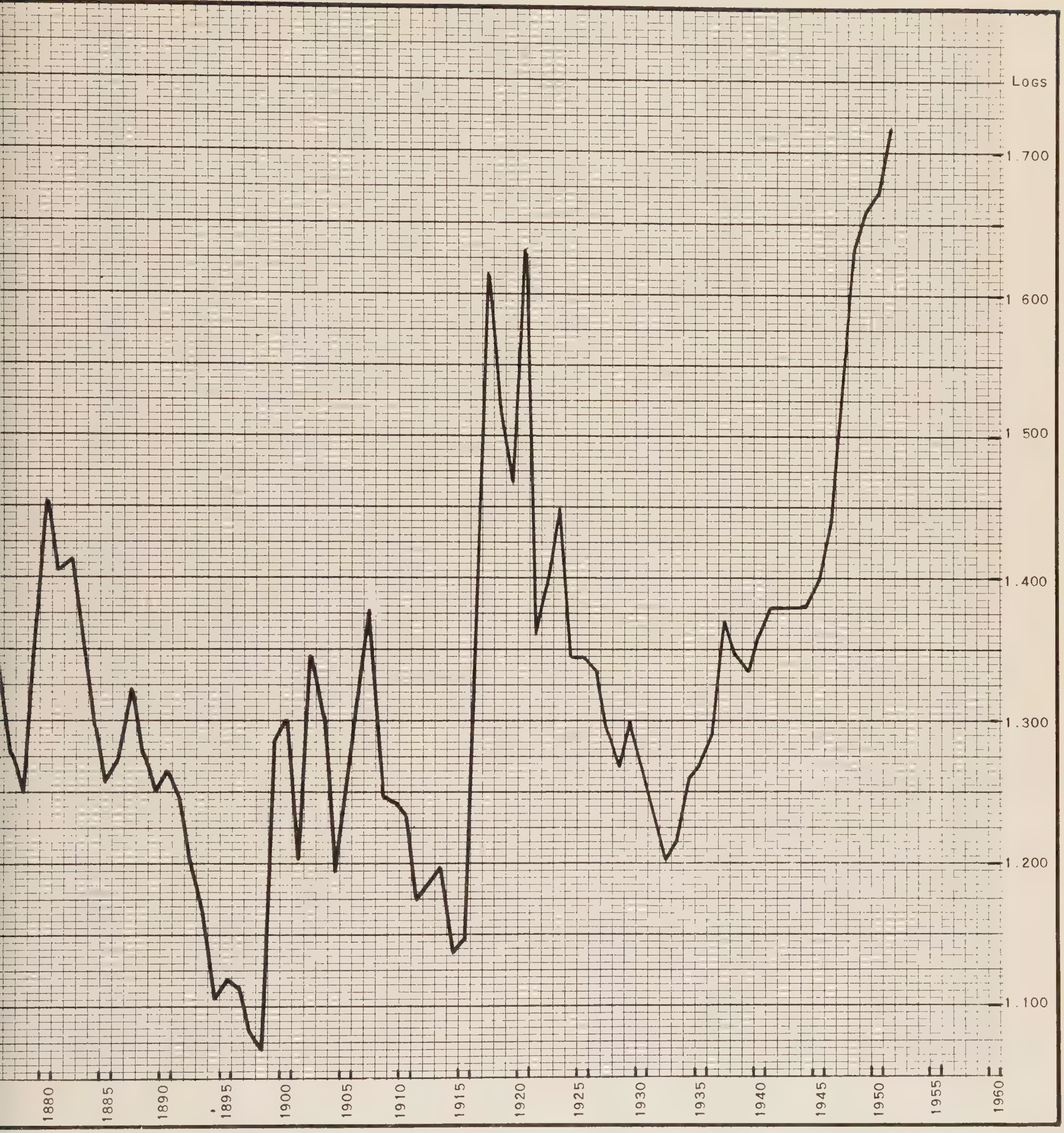


Fig. 2. Pig iron prices, 1784-1951, spliced series of the Foundation for the Study of Cycles. Logs.



Last four values represent adjusted prices.

TABLE 1

PIG IRON PRICES IN THE UNITED STATES, 1784-1951 FROM VARIOUS SOURCES AS INDICATED, TOGETHER WITH A SPLICED SERIES OF PIG IRON PRICES, 1784-1951 AND LOGARITHMIC EQUIVALENTS

	Various Published Prices and Indexes, per Long Ton					Foundation Series	
	A	B	C	D	E	F	G
Year	Price in £, Philadelphia, Cole[1]	Price in dollars, Philadelphia, Cole[1]	Price Philadelphia, Stat. Abs.[2]	Price Chicago, Stat. Abs. 3, 4, 5	Composite index, Sur. Cur. Bus. 6, 7, 8,	Actual spliced series	Logs of spliced series
1784	10.31	27.49				27.49	1.439
85	9.60	25.60				25.60	1.408
86	8.83	23.55				23.55	1.372
87	8.46	22.56				22.56	1.353
88	8.50	22.67				22.67	1.355
89	8.50	22.67				22.67	1.355
1790	8.67	23.12				23.12	1.364
91	9.61	25.63				25.63	1.409
92		25.30				25.30	1.403
93		24.33				24.33	1.386
94		25.21				25.21	1.402
95	10.83	28.88				28.88	1.461
96		31.25				31.25	1.495
97		33.35				33.35	1.523
98		36.65				36.65	1.564
99		38.75				38.75	1.588
1800		35.79				35.79	1.554
01		33.92				33.92	1.530
02		31.09				31.09	1.493
03		30.00				30.00	1.477
04		30.00				30.00	1.477
05		30.92				30.92	1.490
06		35.75				35.75	1.553
07		39.00				39.00	1.591
08		40.00				40.00	1.602
09		40.00				40.00	1.602
1810		41.25				41.25	1.615
11		46.25				46.25	1.665
12		47.50				47.50	1.677
13		47.50				47.50	1.677
14		46.00				46.00	1.663
15		53.90				53.90	1.732
16		50.21				50.21	1.701
17		46.96				46.96	1.672
18		42.33				42.33	1.627
19		36.24				36.24	1.559
1820		35.00				35.00	1.544
21		35.00				35.00	1.544
22		36.25				36.25	1.559
23		37.50				37.50	1.574
24		39.95				39.95	1.602
25		44.44				44.44	1.648
26		46.66				46.66	1.669
27		42.83				42.83	1.632
28		36.33				36.33	1.560
29		35.00				35.00	1.544
1830		35.00				35.00	1.544
31		35.00				35.00	1.544
32		34.66				34.66	1.540
33		39.38				39.38	1.595
34		29.83				29.83	1.475
35		30.21				30.21	1.480
36		41.20				41.20	1.615
37		43.56				43.56	1.639
38		32.58				32.58	1.513
39		33.00				33.00	1.519
1840		30.17	27.88			30.17	1.480
41		28.54				28.54	1.455
42		28.29				28.29	1.452
43		25.54				25.54	1.407
44		28.59				28.59	1.456
45		32.59				32.59	1.513
46		30.94				30.94	1.491
47		31.49				31.49	1.498
48		28.39				28.39	1.453
49		24.47				24.47	1.389
1850		23.19	20.88			23.19	1.365
51		23.03	21.38			23.03	1.362
52		24.50	22.63			24.50	1.389
53		34.82	36.13			34.82	1.542
54		36.63	36.88			36.63	1.564
55		27.75	27.75			27.75	1.443
56		27.91	27.18			27.18	1.434
57		27.17	26.34			26.34	1.421
58		22.71	22.19			22.19	1.346
59		24.04	23.33			23.33	1.368
1860		23.96	22.70			22.79	1.356
61		21.42	20.26			20.26	1.307
62			23.92			23.92	1.379
63			35.24			35.24	1.547
64			59.22			59.22	1.772
65			46.08			46.08	1.664
66			46.84			46.84	1.671
67			44.08			44.08	1.644

	Various Published Prices and Indexes, per Long Ton					Foundation Series	
	A	B	C	D	E	F	G
Year	Price in £. Philadelphia Cole[1]	Price in dollars, Philadelphia Cole[1]	Price Philadelphia. Stat. Abs.[2]	Price Chicago Stat. Abs. 3,4,5.	Composite Index Sur. Cur. Bus. 6,7,8	Actual spliced series	Logs of spliced series
1868			39.25			39.25	1.594
69			40.61			40.61	1.609
1870			33.23			33.23	1.522
71			35.08			35.08	1.545
72			48.94			48.94	1.690
73			42.79			42.79	1.631
74			30.19			30.19	1.480
75			25.53			25.53	1.407
76			22.19			22.19	1.346
77			18.92			18.92	1.277
78			17.67			17.67	1.247
79			21.72			21.72	1.337
1880			28.48			28.48	1.455
81			25.17			25.17	1.401
82			25.77			25.77	1.411
83			22.42			22.42	1.351
84			19.81			19.81	1.297
85			17.99			17.99	1.255
86			18.71			18.71	1.272
87			20.93			20.93	1.321
88			18.88	17.19		18.88	1.276
89			17.76	15.77		17.76	1.249
1890			18.41	16.66		18.41	1.265
91			17.52	14.95		17.52	1.244
92			15.75	13.88		15.75	1.197
93			14.52	12.80		14.52	1.162
94			12.66	10.56		12.66	1.102
95			13.10	11.80		13.10	1.117
96			12.95	11.64		12.95	1.112
97			12.10	10.68		12.10	1.083
98			11.66	11.32		11.66	1.067
99			19.36	18.40		19.36	1.287
1900			19.98	19.47		19.98	1.301
01			15.87	15.38		15.87	1.200
02			22.19	20.86		22.19	1.346
03			19.92	19.25		19.92	1.299
04			15.57	14.37		15.57	1.192
05			17.88	17.65		17.88	1.252
06			20.98	20.43		20.98	1.322
07			23.89	24.50		23.89	1.378
08			17.70	17.57		17.57	1.245
09			17.81	17.49		17.49	1.243
1910			17.36	17.09		17.09	1.233
11			15.71	14.83		14.83	1.171
12			16.56	15.32		15.32	1.185
13				15.85	15.42	15.85	1.200
14				13.60	13.52	13.60	1.134
15				14.01	14.15	14.01	1.146
16				20.26	20.31	20.26	1.307
17				41.31	39.99	41.31	1.616
18				33.25	34.38	33.25	1.522
19				29.16	29.91	29.16	1.465
1920				42.53	43.80	42.53	1.629
21				22.93	24.05	22.93	1.360
22				24.85	25.00	24.85	1.395
23				28.16	27.15	28.16	1.450
24				22.10	21.87	22.10	1.344
25				22.09	21.32	22.09	1.344
26				21.64	21.06	21.64	1.335
27				19.68	19.35	19.68	1.294
28				18.54	18.32	18.54	1.268
29				20.00	19.15	20.00	1.301
1930				18.47	18.18	18.47	1.266
31				17.35	16.45	17.35	1.239
32				15.87	14.99	15.87	1.201
33				16.47	16.30	16.47	1.217
34				18.19	18.64	18.19	1.260
35				18.68	19.12	18.68	1.271
36				19.60	20.00	19.60	1.292
37				23.49	23.60	23.49	1.371
38				22.20	22.35	22.20	1.346
39				21.59	21.75	21.59	1.334
1940				23.00	23.15	23.00	1.362
41				24.00	24.10	24.00	1.380
42				24.00	24.19	24.00	1.380
43				24.00	24.19	24.00	1.380
44				24.00	24.17	24.00	1.380
45				25.02	25.19	25.02	1.398
46				27.64	27.84	27.64	1.442
47				34.80	34.86	34.86	1.542
48				41.69	43.36	*42.85	1.632
49					46.98	**45.89	1.662
1950					48.27	**47.15	1.673
51					53.62	**52.38	1.719

*Composite Index x .98824. See text
**Composite Index x .97688. See text

THE 17¾-YEAR CYCLE IN PIG IRON PRICES 1784–1951

By Edward R. Dewey
Director, Foundation for the Study of Cycles

Summary

Examination of pig iron prices, 1784-1951, shows a series of cycles which average 17 3/4-years in length. Typical timing places crests midway between 1814 and 1815 every 17 3/4 years thereafter. The typical overall amplitude is 37.1% of trend. No attempt is made to evaluate the significance of the behavior. No explanation of the behavior is offered. However the existence of a 17 2/3-year rhythmic cycle in commercial and industrial failures, 1857-1950 and a 17 3/4-year cycle in Arizona tree rings, present on the average in each third of the data, 1190 A.D. to 1897 A.D. is noted. More research is called for.

PIG iron prices are available from 1784 to date.[1] A chart of the logarithms of a series of such prices[1] is shown by means of the solid line in Fig. 1.

A 9-Year Cycle Removed

Simple inspection shows a tendency for crests to come at about 9-year intervals. This irregularity can be removed by means of a 9-year moving average.[2] A 9-year moving average of the logs of the data was therefore computed, centered, and plotted as a broken line in Fig. 1. Such a moving average is of course a geometric moving average of the data (the 9th root of the product of each successive group of nine terms).

The process of computing a 9-year moving average loses four values at each end of the series of figures. Consequently the moving average runs only from 1788 to 1947.

An 18-Year Cycle

Simple inspection of the broken line in Fig. 1 shows the presence of a recurring cycle of about 18 years in length, even though about half of any such cycle will have been removed by the 9-year moving average.[2]

To remove any such 18-year tendency, as nearly as may be, a 2-year moving average of an 18-year moving average of the logs of the data is next computed.[2] It is centered and plotted as a broken line in Fig. 2. In this calculation we lose nine values at each end of the series.

We now compare the 9-year moving average with the 18-year moving average, as in Fig. 3 and in Fig. 4. Fig. 3 plots the two moving averages and Fig. 4 shows the difference between the 9-year moving average and the 18-year moving average.

To avoid negative logarithms and to convert these differences from anti-logs of ratios to anti-logs of percentages, 2.0 is added as a constant to each 9-year moving average value before the corresponding value of the 18-year moving average is subtracted.

As the 18-year moving average removes all of any regularly recurring 18-year waves that might be present in this series of figures, and the 9-year moving average removes only half of any such waves, the difference between the two series of figures, calculated year by year, will show approximately half of any regular cycle near this length.

An 18-Year Time Chart

Simple inspection continues to show a rhythmic cycle of about 18 years in length, as before. The exact length is determined, as nearly as may be, by constructing an 18-year Time Chart of the difference of the logs, as in Fig. 5.[3]

A tendency for highs and lows to come at slightly less than 18-year intervals is shown by the fact that, on the whole, highs and lows both tend to occur earlier in the cycle as one advances from left to right across the page. From Fig. 5 the length of the cycle is determined to be 17 3/4 years. The ideal 17 3/4-year timing is shown by means of a broken line.

The Typical Wave

The typical wave in the 9-year moving averages as disclosed by a 17 3/4-year periodic table (Table 1) is charted in Fig. 6. If the typical cycle in the original logs is zigzag in shape, the 9-year moving average will remove half the amplitude.[2] Assuming the shape of the typical cycle to be zigzag, the amplitude of this cycle averages 120.2% of trend at time of crest and 83.1% of trend at time of trough, as diagrammed in Fig. 6. A 9-year moving average of the ideal 17 3/4-year wave is shown in Fig. 6 in comparison with the typical wave as found in the moving averages. The correspondence is entirely satisfactory. Crests are seen to fall midway between 1814 and 1815, and every 17 3/4 years thereafter: troughs 8.9-years after crests.

According to this reckoning, the last trough of the **ideal** cycle was due in 1948.1; the next crest of the **ideal** cycle is due at the end of 1956.

A diagram of the ideal 17 3/4-year cycle is plotted, by means of a broken line, in Fig. 4.

Cause Unknown

It should be emphasized that no one knows whether or not this behavior is the result of some underlying cyclic force, or is merely the result of a variety of separate causes which just happened to fall at about 17 3/4 years apart.

Even if it is the result of some underlying cyclic force, no one knows what this force is, or whether or not it will continue.

But one thing is certain and that is, even if there is a cyclic force involved, the **actual** crest is almost certain to be a number of years one way or the other from perfect timing. Even assuming the cycle significant, the tendency for these figures to show evidence of a 17 3/4-year cycle is only one of many factors involved in the determination of the actual price.

Similar Cycle in Failures

No explanation of this behavior is advanced, but the presence of a cycle of approximately the same length in the liabilities of commercial and financial failures in the United States, 1857-1950,[4] will not excape the notice of careful readers of this Journal. It may also be noteworthy that the timing of the crests and troughs of the two series are within a year of perfect inverse correspondence.

17 3/4-Year Cycle in Tree Rings

A study of cycles in tree ring widths in Arizona also shows a 17 3/4-year cycle, present on the average from 1100 A.D.-1897 A.D.[5] This cycle is present on the average in each third of the data as shown by Fig. 7.

Crests of the typical tree ring cycle were found to fall midway between 1106 and 1107 and every 17 3/4-years thereafter but this timing is not quite correct for the date of greatest width in the rings themselves due to the distortions in time introduced by the method of preparing the data, and because the true length [of the tree ring cycle] is perhaps not exactly 17 3/4 years.

Moreover, the work has not been done to prove that this cycle in tree ring widths is truly rhythmic. All that has been done is to show that this cycle is present on the a v e r a g e in each third of the data.

Finally, even if the cycles in two phenomena are both rhythmic, and both have e x a c t l y the same wave length and crests in both come at e x a c t l y the same time, these facts would offer no p r o o f of direct or indirect relationship. However, even identity of wave length by itself, if it can be established, is quite provocative.

More Study Called For

The seeming identity of wave length of 17 3/4-year cycles in pig iron prices, 1784-1950 and in tree ring widths 1100 A.D.-1897 A.D. would therefore seem to warrant further study.

References

1. Malinowski, Alla, "An Index of Pig Iron Prices," 1784-1951, Journal of Cycle Research, Spring 1952, Vol. 1, No. 3, p.68.
2. Dewey, Edward R., **Cycle Analysis: The Moving Average**. Technical Bulletin No. 4, Foundation for the Study of Cycles.

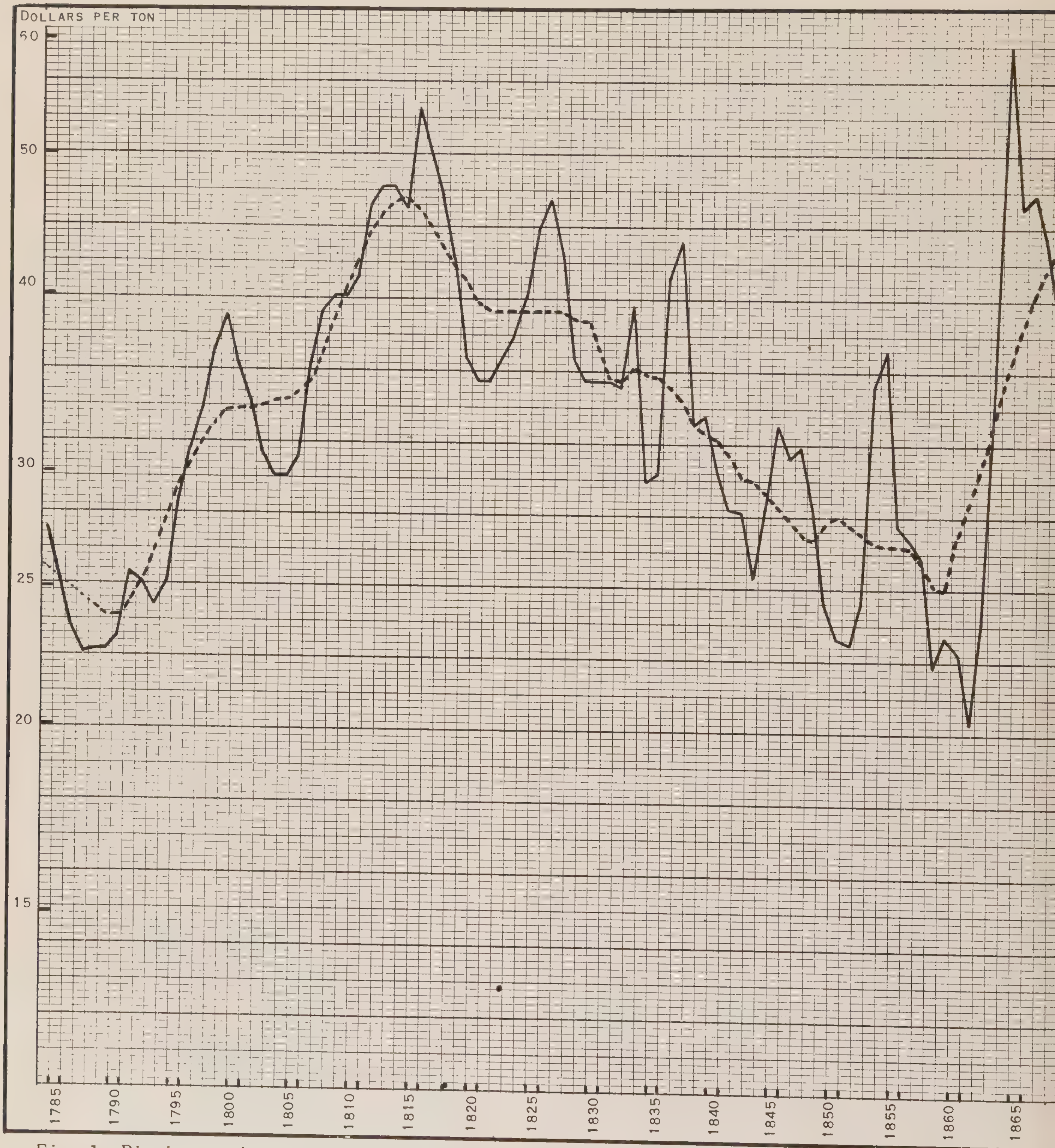
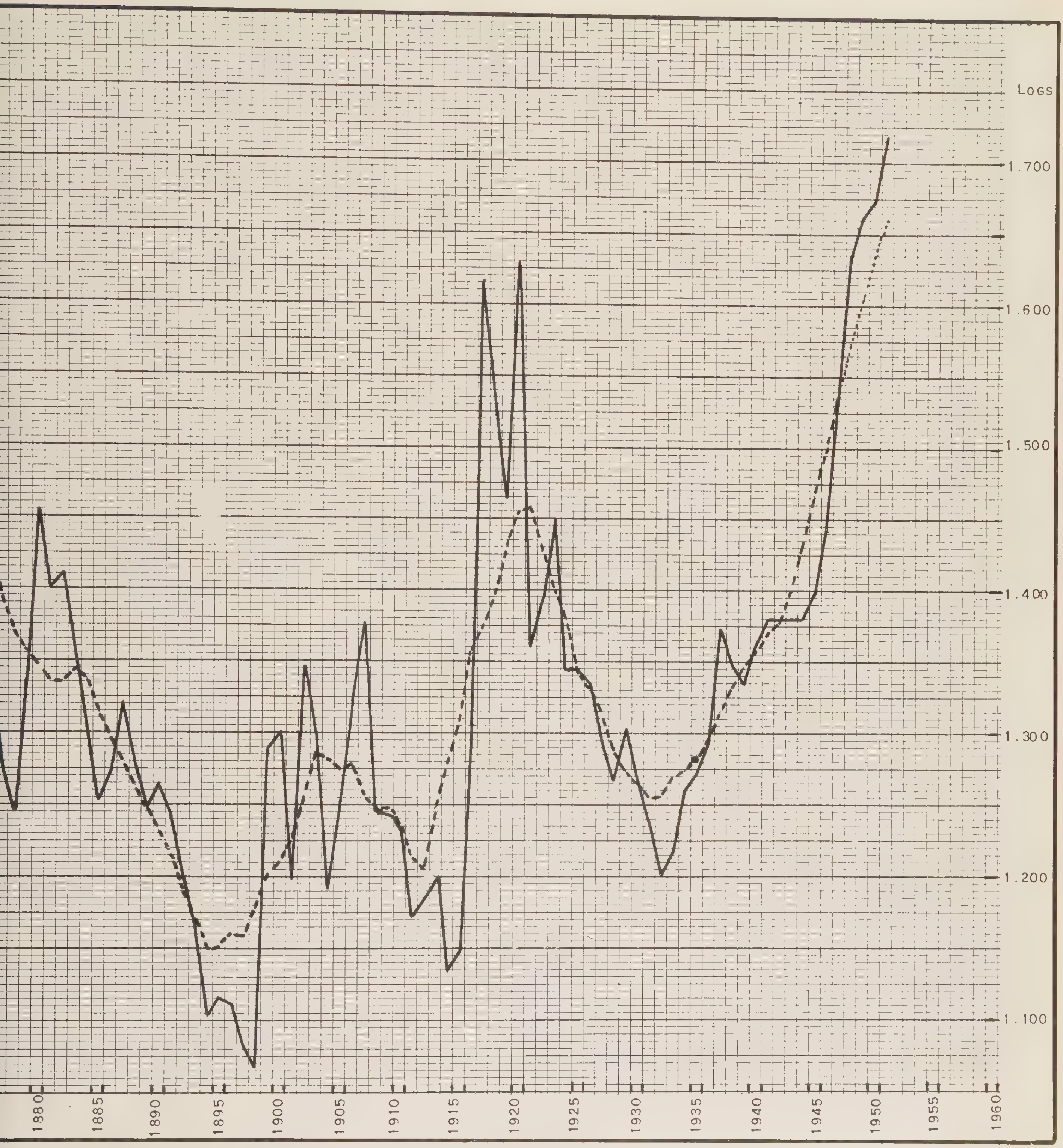


Fig. 1. Pig iron prices, 1784-1951, spliced series, together with their 9-year moving average. Logs. Note arbitrary extrapolation for 4 years at each end of series.



The 9-year moving average smoothes out the 9-year cycle present in these figures and also largely eliminates all the other short-term cycles. 1947-1951 adjusted prices.

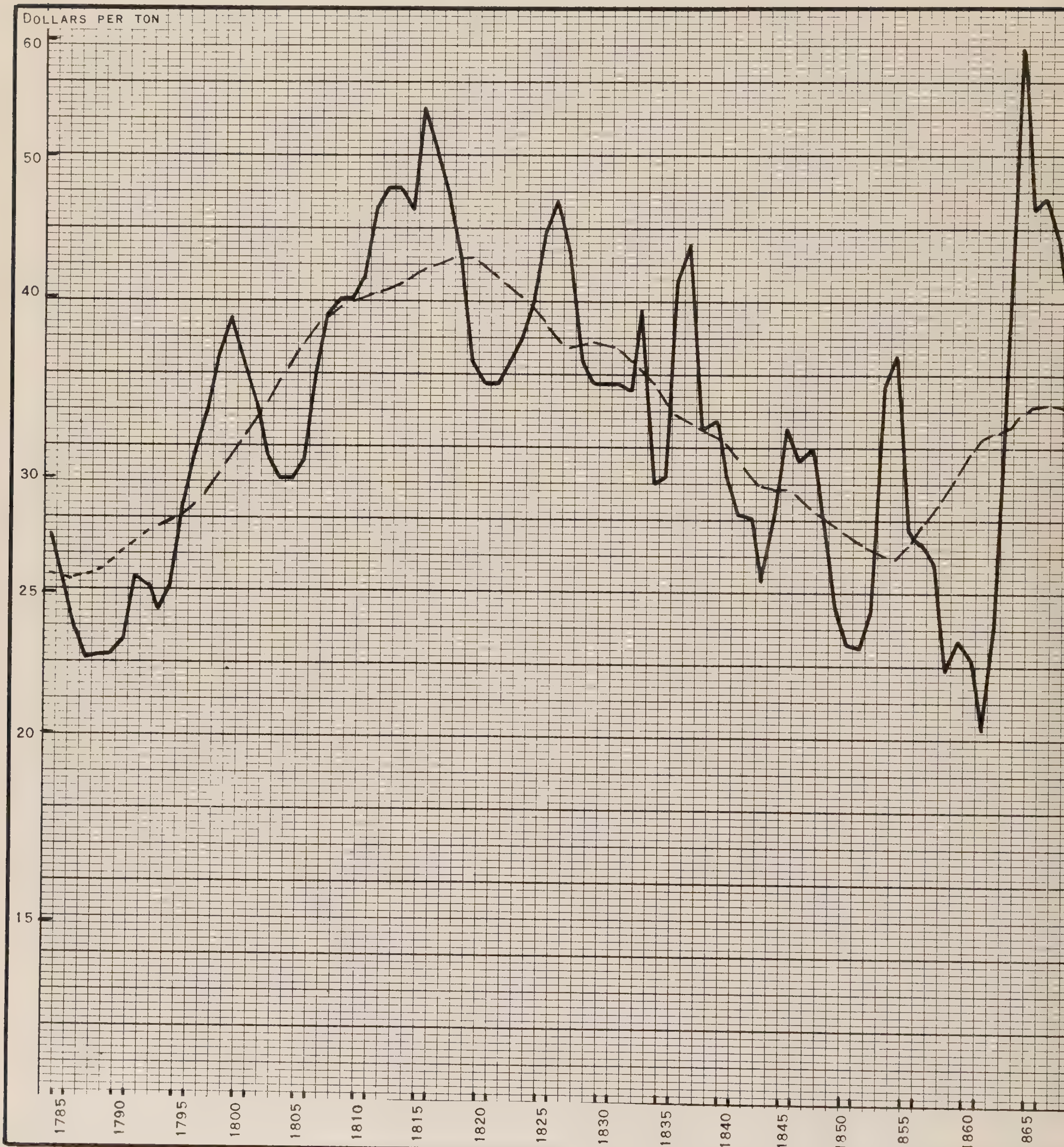
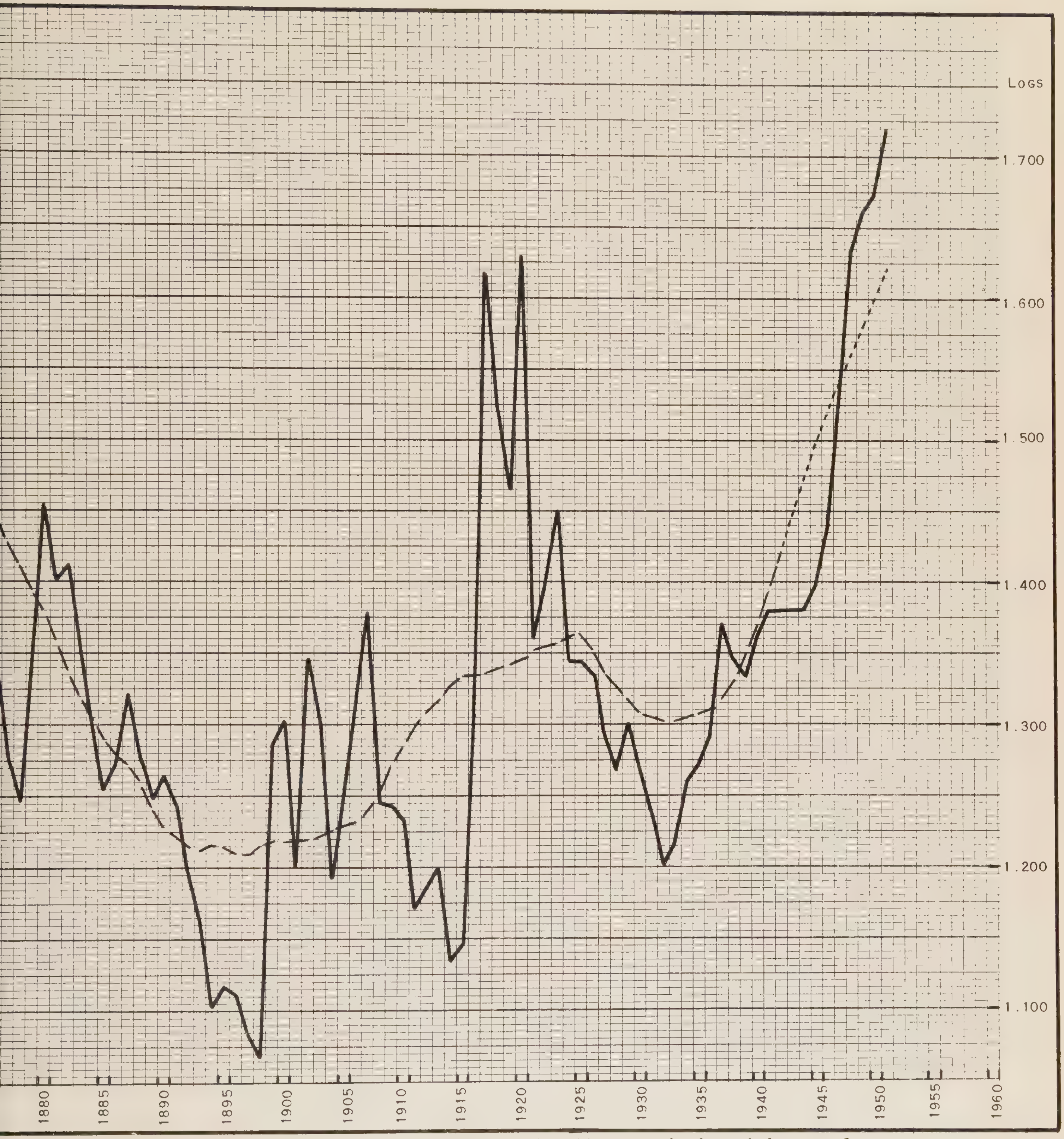


Fig. 2. Pig iron prices, 1784-1951, spliced series, together with their centered 18-year moving average. Logs. Note arbitrary extrapolation for 9 years of each end of series.



The 18-year moving average eliminates cycles 18 years in length but conforms more or less to the major fluctuations. Last four values represent adjusted prices.

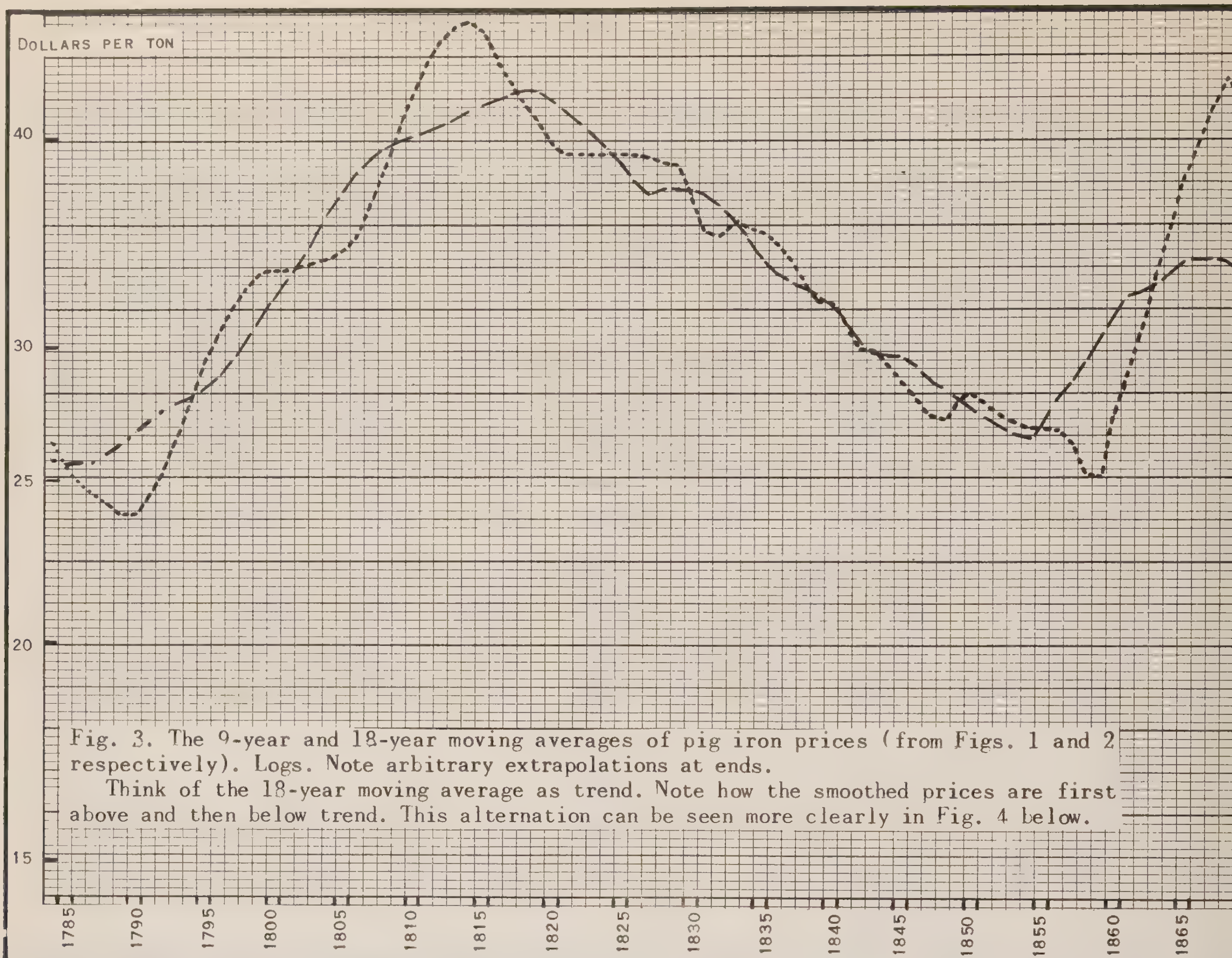


Fig. 3. The 9-year and 18-year moving averages of pig iron prices (from Figs. 1 and 2 respectively). Logs. Note arbitrary extrapolations at ends.

Think of the 18-year moving average as trend. Note how the smoothed prices are first above and then below trend. This alternation can be seen more clearly in Fig. 4 below.

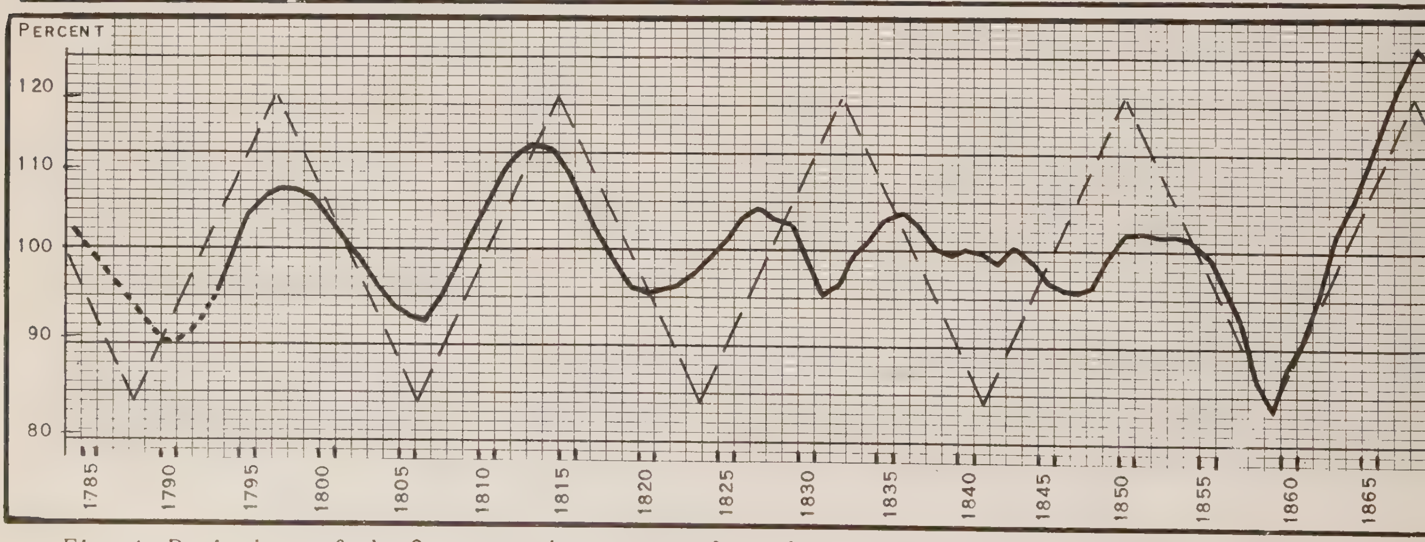
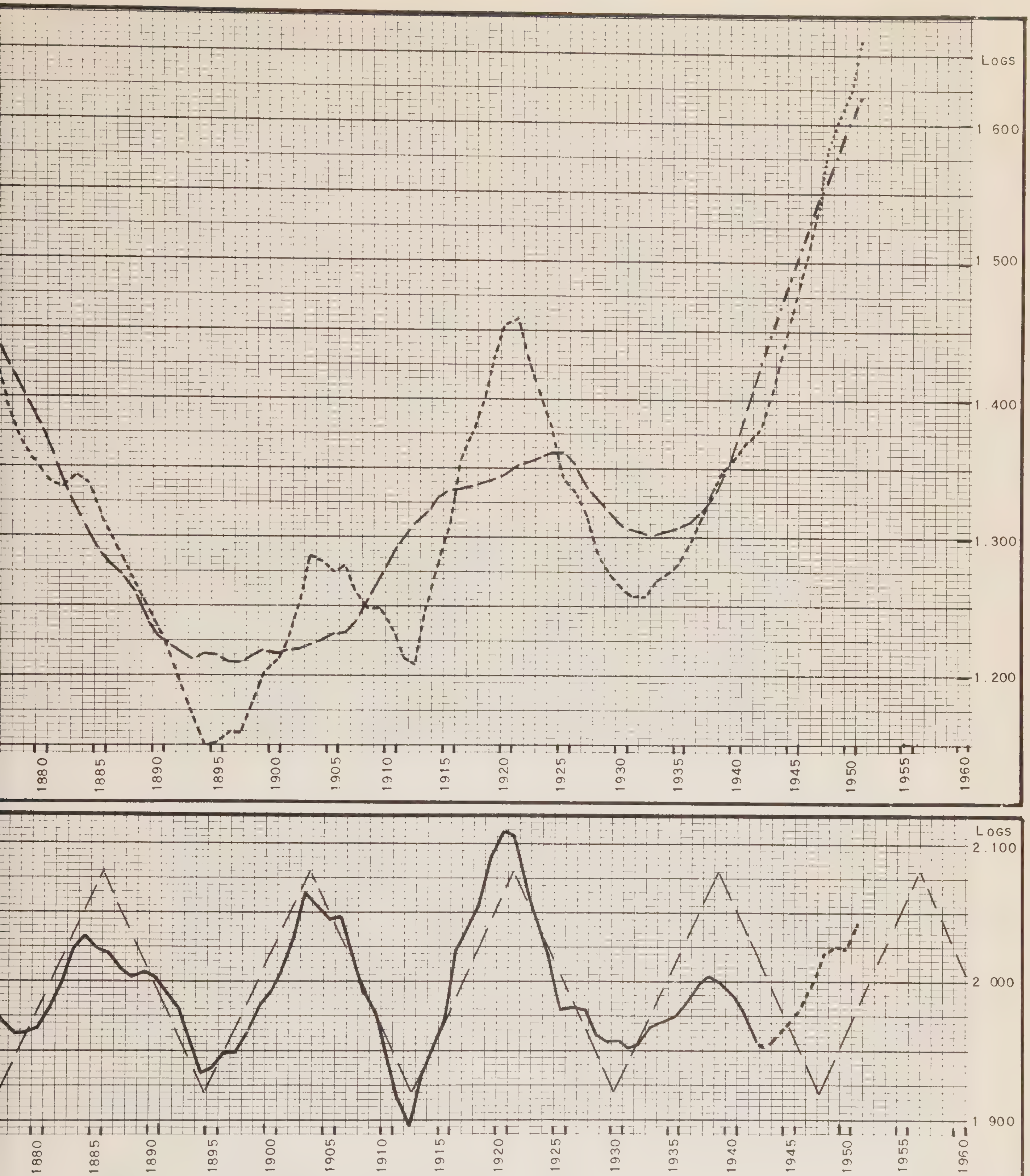


Fig. 4. Deviations of the 9-year moving average from the 18-year moving average, together with an ideal 17 3/4-year cycle shown by means of a zigzag line. Logs.

The ideal 17 3/4-year cycle has been projected into the future to show in a general way what will happen if this cycle continues.



This chart is the same as Fig. 3 except that the 18-year moving average trend has been "pulled straight" and used as an axis.

The last trough in the ideal cycle occurred at 1948.1 The next crest is due at 1957.0 (January 1, 1957)

Pig Iron Prices. 17¾-year periodic table. Data: Deviations of 9-yr.mov.a

Base	1	2	3	4	5	6	7	8	9
1783.5	2.010	1.999	1.990	1.980	1.970	1.958	1.951	1.954	1.96
1801.5	1.995	1.982	1.971	1.965	1.963	1.974	1.990	2.008	2.02
1819.5	1.973	1.974	1.981	1.988	1.996	2.006	2.017	2.022	2.01
1836.5	2.013	2.000	1.998	2.001	1.999	1.993	2.001	1.994	1.98
1854.5	1.997	1.983	1.964	1.933	1.917	1.941	1.955	1.980	2.00
1872.5	1.995	1.973	1.971	1.983	1.970	1.962	1.963	1.966	1.97
1890.5	1.992	1.976	1.957	1.954	1.937	1.949	1.949	1.964	1.98
1907.5	1.991	1.977	1.950	1.915	1.897	1.931	1.951	1.971	2.02
1925.5	1.981	1.980	1.961	1.957	1.957	1.951	1.954	1.967	1.97
1943.5									
Average	1.994	1.983	1.971	1.962	1.956	1.963	1.970	1.981	1.99

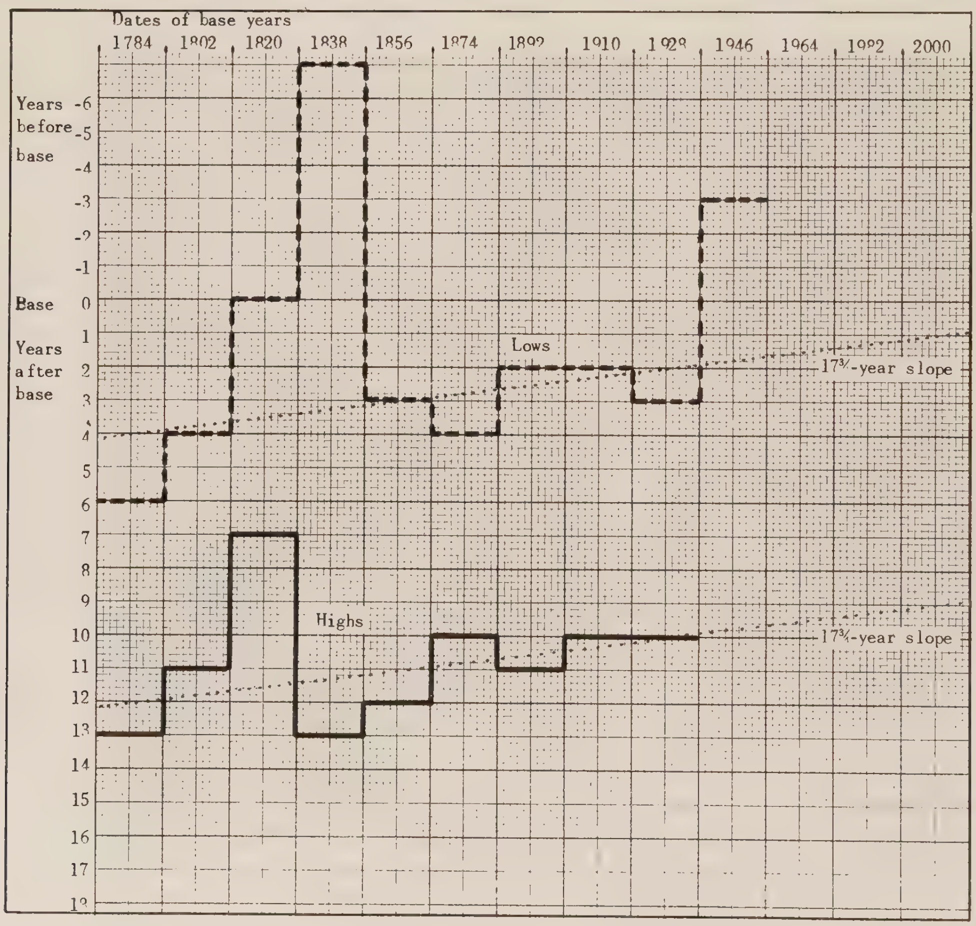


Fig. 5. An 18-year time chart of the difference of the logs as in Fig. 4. Note the tendency of highs and lows to be higher on the page as we go from left to right. This upward slope shows the 17¾-year timing; a broken line has been added to guide your eye.

from the 18-yr. mov. av. (col. M of table 1)

10	11	12	13	14	15	16	17	17¾
1.978	**1.998**	2.018	2.027	2.032	2.031	2.027	2.016	2.005
2.041	2.050	2.054	2.052	2.042	2.025	2.007	**1.992**	**1.982**
2.014	**1.996**	**1.978**	**1.982**	**1.998**	2.005	2.016	2.018	×
1.980	**1.978**	**1.981**	**1.998**	2.009	2.009	2.007	2.008	2.006
2.025	2.047	2.070	2.089	2.107	2.097	2.079	2.047	2.016
1.998	2.024	2.033	2.024	2.020	2.009	2.003	2.006	2.003
1.993	2.007	2.033	2.064	2.055	2.045	2.047	2.019	×
2.039	2.057	2.090	2.107	2.106	2.072	2.044	2.018	**1.980**
1.974	**1.984**	**1.996**	2.003	**1.999**	**1.989**	**1.976**	**1.957**	***1.952**
2.005	2.016	2.028	2.038	2.041	2.031	2.023	2.009	

* Estimated

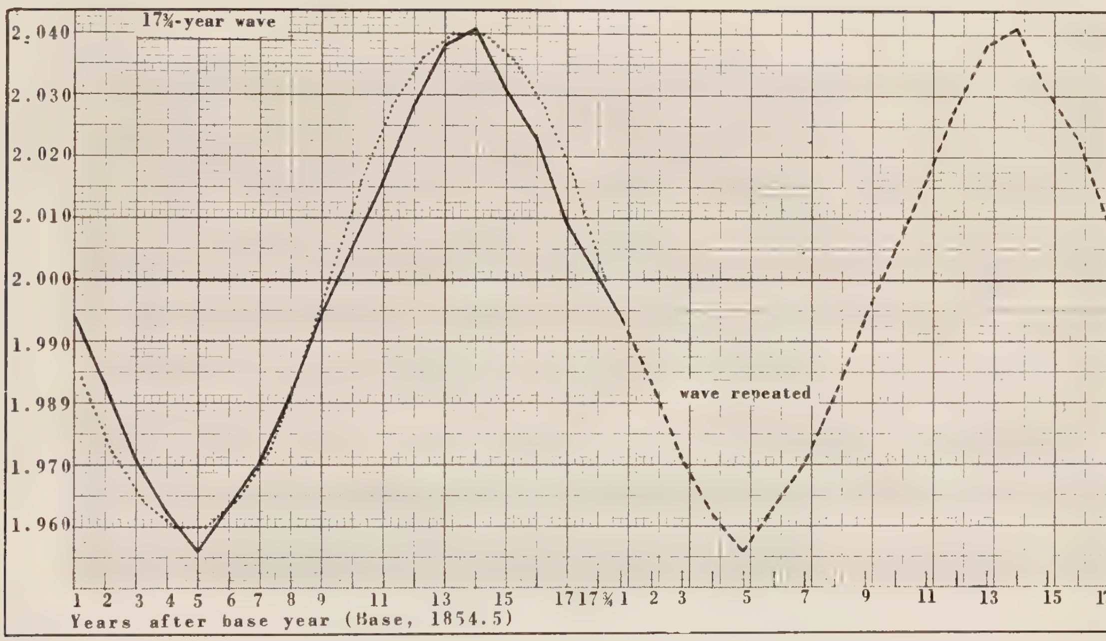


Fig. 6. Typical 17¾-year wave as found in the periodic table above, repeated in phantom, together with a 9-year moving average of the ideal wave, shown by means of a dotted line.

3. Dewey, Edward R., **Cycle Analysis: A Description of the Hoskins Time Chart.** Technical Bulletin No. 3, Foundation for the Study of Cycles.

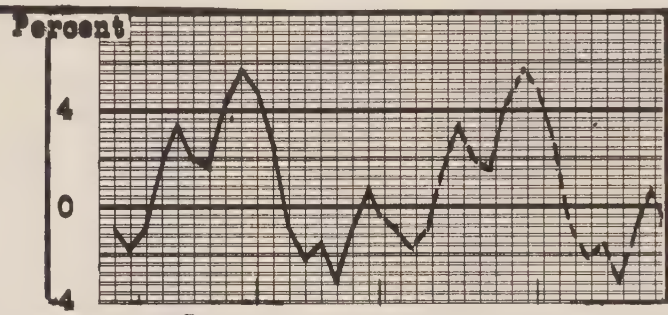
4. Dewey, Edward R., "An Economic Cycle—The 17 2/3-Year Rhythm in Liabilities of Commercial and Industrial Failures in the United States, 1857-1950." **Journal of Cycle Research**, Autumn, 1951, Vol. 1, No. 1, pp. 2-5.

5. Dewey, Edward R., **Cycles in Tree Ring Widths—Lukachukai District, Arizona, Hint of a 17 3/4-year rhythm.** Report No. 5, Foundation for the Study of Cycles, Riverside, Connecticut, 1949.

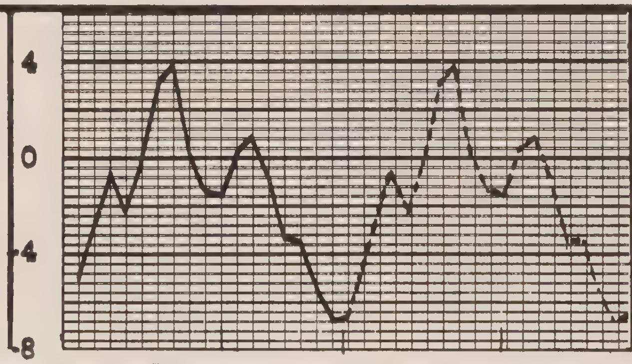
FIG. 7

THE AVERAGE $17\frac{3}{4}$-YEAR WAVE IN TREE RING WIDTHS
IN THE LUKACHUKAI DISTRICT, ARIZONA, 1100 A.D. to 1897 A.D.

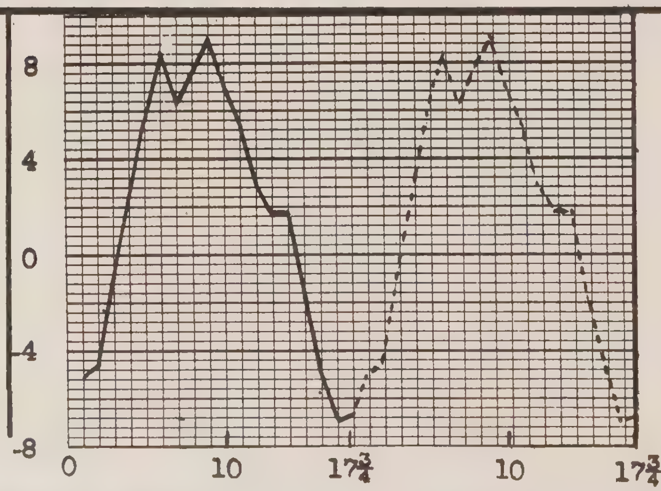
The charts show for each third of the period the 7-year moving average of the average median of the percentages that the actual widths are of their uncentered three-decade moving averages, repeated in phantom.



Curve A. The average $17\frac{3}{4}$-year wave in the 266-year period 1100-1365.



Curve B. The average $17\frac{3}{4}$-year wave in the 266-year period 1366-1631.



Curve C. The average $17\frac{3}{4}$-year wave in the 266-year period 1632-1897.

TESTING CYCLES FOR STATISTICAL SIGNIFICANCE

Applying the Bartels Test of Significance to a Time Series Cycle Analysis

By Charles F. Armstrong

In the cycle analysis of time series, the question almost invariably arises as to whether or not a given period shows statistical evidence of reality. Among the various devices used in testing for significance, Bartels' technique seems to give perhaps the most reasonable results. This test of significance, when applied to the cycle analysis of time series, reflects the degree to which a particular periodicity is consistently present throughout the series under study, as well as the persistence of the cycle, i.e., the number of waves contained in the series. In this test the cycle curve for the given period under test is fitted to the entire series, and the amplitude of the resulting measured cycle is compared with the amplitude which might be expected to occur as a result of chance factors alone. This expected amplitude is determined by fitting the cycle curve for the given period separately to successive segments of the series, each segment being one period in length. From the n individual amplitudes so obtained, an estimate of the expected average amplitude is computed in accordance with the rule used in determining the dispersion of the mean, i.e., by dividing the quadratic mean of the individual amplitudes by $\sqrt{n}$. By comparing the measured average amplitude as obtained by fitting the cycle curve to the entire series with the expected average amplitude, we have a direct means, through the use of standard probability formulae, of arriving at a mathematical measure of the genuineness of the observed cycle. As will be seen, the resulting measure of genuineness will be high in cases where individual cycles exhibit stability in both amplitude and timing, and low where the opposite conditions obtain. Also, the value of n, the number of individual periods contained in the series, has a positive effect on this measure. Of course, for n=1 the test is meaningless.

Since periods other than the particular one under analysis affect both the measured and expected average amplitudes in the same way and to the same degree, the final measure of genuineness is not affected by such disturbing elements. Likewise, the effects of any serial correlation present in the series is nullified by appearing in both sides of the ratio of measured to expected amplitude. Hence, the test may with safety be applied to series of deviations from moving averages or from other trend or smoothing curve devices, the use of which may change the amount of serial correlation present in the series.

The Bartels test is not designed primarily as a means of locating the periods of cycles present in a series. Its chief value lies in its application as a test of significance after the period has been located by some other means. However, in the process of locating the exact period, it is often possible to set up the work processes and papers in such a way as to facilitate the application of the Bartels test after the period has been determined. The following tables and chart illustrate the application of the test to the results of a harmonic analysis of a typical economic series.

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Table I shows the initial and final portions of a monthly series of relative deviations from trend of an index of economic activity in the United States, from 1899 to 1939, inclusive. Investigation has indicated the presence in this series of a fairly marked cycle closely approximating 41 months in duration. The problem is to apply the Bartels test to this cycle as isolated by methods of harmonic analysis, and so to evaluate the probability that it could be the result of chance conformations in the data.

The first step is to break up the entire series into segments each 41 months in length. Each of these segments, of which there are twelve, is subjected to a standard harmonic analysis for a 41-month period. The method of doing this, for the first and twelfth segments, is shown on Table II.[1] For each of the twelve analyses, the constants A and B are computed as described in Table II, and the twelve sets of values so derived, together with their averages and the sums of their squares, are tabulated in Table III.

Chart I[2] is a scatter diagram depicting the tendency of the twelve sets of A and B values to cluster about their average values. Each pair of A and B values determines a point "p" on the chart. The twelve sets thus determine twelve points, p_1, p_2, p_3, ... p_{12}, and the average values determine point "P". The vector Op_1 describes the phase and amplitude[3] of the sinusoid fitted by means of harmonic analysis to the first segment of the series, the vector Op_2 represents that fitted to the second segment, and so on. Vector OP is the average of the twelve individual vectors, and represents the result of fitting a single 41-month sinusoid to the entire series. The degree to which the individual points p_1, p_2, p_3, ... p_{12} cluster about P as contrasted to about O is, according to this significance test, indicative of the probable statistical genuineness of the 41-month cycle in this series.

As shown by Table III, the average vector OP has an amplitude of 133.49, and the quadratic mean of the amplitudes of the twelve individual vectors is 203.49. If we assume that there is no real 41-month periodicity in the data under study, and

TABLE I

AN INDEX OF ECONOMIC ACTIVITY IN THE UNITED STATES

PERCENTAGE DEVIATIONS FROM TREND

(INITIAL AND FINAL PORTIONS ONLY)

INITIAL PORTION	1899	1900	1901
JANUARY	-1.8	-0.4	-4.3
FEBRUARY	-2.8	-1.7	-1.2
MARCH	-0.2	-3.0	+0.2
APRIL	+0.2	-3.8	+4.1
MAY	+2.4	-4.9	+6.2
JUNE	+2.8	-9.1	+6.5
JULY	+4.1	-10.2	+7.2
AUGUST	+3.8	-11.6	+5.0
SEPTEMBER	+3.4	-11.2	+4.2
OCTOBER	+3.4	-10.7	+1.7
NOVEMBER	+1.4	-10.3	+1.8
DECEMBER	+3.8	-7.1	-0.2
FINAL PORTION	**1937**	**1938**	**1939**
JANUARY	+1.4	-28.6	-12.3
FEBRUARY	+3.3	-26.9	-11.3
MARCH	+5.1	-26.5	-10.5
APRIL	+6.0	-27.7	-13.0
MAY	+6.5	-28.1	-13.0
JUNE	+3.4	-27.9	-10.2
JULY	+2.6	-23.4	-9.8
AUGUST	+0.6	-19.7	-7.8
SEPTEMBER	-3.0	-17.8	-2.3
OCTOBER	-14.2	-16.8	+3.8
NOVEMBER	-24.3	-12.5	+6.0
DECEMBER	-29.9	-13.4	+6.2

that, therefore, the apparent cyclical movements are the result of chance alone, then the twelve p-points must be considered as random selections from a field of such points distributed about and centered at O. Moreover, if the condition is purely random, the dispersion of all the points in the field about O should not be greatly different from the dispersion of the twelve selected points about O. Under such conditions, the expected amplitude of the single sinusoid fitted to the entire series may be computed as $203.49 \div \sqrt{12} = 58.74$, as contrasted to the measured amplitude to its expectancy is $133.49 \div 58.74 = 2.27$. The probability that this occurs as the result of chance alone is $\frac{1}{e^{(2.27)^2}} = \frac{1}{185}$, where e is the base of natural logarithms.[4]

The illustrative example given here is based on harmonic analysis, but the Bartels test may be applied to the results of other methods of cycle determination, as

TABLE II

41-MONTH HARMONIC ANALYSES OF FIRST AND TWELFTH SEGMENTS OF SERIES

(a) Month	(b) θ* (a ÷ 41)	(c) Sin. θ	(d) Cos. θ	(e) 1st Segment Y#	Y Sin.θ	Y Cos.θ	(f) 12th Segment Y #	Y Sin.θ	Y Cos.θ
1	2.44%	0.153	0.988	-1.8	-.28	-1.78	-6.1	-.93	-6.03
2	4.88	.302	.953	-2.8	-.85	-2.67	-3.7	-1.12	-3.53
3	7.32	.444	.896	-0.2	-.09	-0.18	-3.5	-1.55	-3.14
4	9.76	.576	.817	+0.2	+.12	+0.16	-1.7	-.98	-1.39
5	12.20	.694	.720	+2.4	+1.67	+1.73	+2.2	+1.53	+1.58
6	14.63	.795	.606	+2.8	+2.23	+1.70	+1.4	+1.11	+.85
7	17.07	.878	.478	+4.1	+3.60	+1.96	+3.3	+2.90	+1.58
8	19.51	.941	.338	+3.8	+3.58	+1.28	+5.1	+4.80	+1.72
9	21.95	.982	.190	+3.4	+3.34	+0.65	+6.0	+5.89	+1.14
10	24.39	.999	.039	+3.4	+3.40	+0.13	+6.5	+6.49	+.25
11	26.83	.994	-.115	+1.4	+1.39	-0.16	+3.4	+3.38	-.39
12	29.27	.964	-.265	+3.8	+3.66	-1.01	+2.6	+2.51	-.69
13	31.71	.912	-.409	-0.4	-.36	+0.16	+0.6	+.55	-.25
14	34.15	.839	-.543	-1.7	-1.43	+0.92	-3.0	-2.52	+1.63
15	36.59	.746	-.666	-3.0	-2.24	+2.00	-14.2	-10.59	+9.46
16	39.02	.636	-.771	-3.8	-2.42	+2.93	-24.3	-15.45	+18.74
17	41.46	.511	-.859	-4.9	-2.50	+4.21	-29.9	-15.28	+25.68
18	43.90	.374	-.927	-9.1	-3.40	+8.44	-28.6	-10.70	+26.51
19	46.34	.228	-.973	-10.2	-2.33	+9.92	-26.9	-6.13	+26.17
20	48.78	.076	-.997	-11.6	-.88	+11.57	-26.5	-2.01	+26.42
21	51.22	-.076	-.997	-11.2	+.85	+11.17	-27.7	+2.11	+27.62
22	53.66	-.228	-.973	-10.7	+2.44	+10.41	-28.1	+6.41	+27.34
23	56.10	-.374	-.927	-10.3	+3.85	+9.55	-27.9	+10.43	+25.86
24	58.54	-.511	-.859	-7.1	+3.63	+6.10	-23.4	+11.96	+20.10
25	60.98	-.636	-.771	-4.3	+2.73	+3.32	-19.7	+12.53	+15.19
26	63.41	-.746	-.666	-1.2	+.90	+.80	-17.8	+13.28	+11.85
27	65.85	-.839	-.543	+0.2	-.17	-.11	-16.8	+14.10	+9.12
28	68.29	-.912	-.409	+4.1	-3.74	-1.68	-12.5	+11.40	+5.11
29	70.73	-.964	-.265	+6.2	-5.98	-1.64	-13.4	+12.92	+3.55
30	73.17	-.994	-.115	+6.5	-6.46	-0.75	-12.3	+12.23	+1.41
31	75.61	-.999	.039	+7.2	-7.19	+0.28	-11.3	+11.29	-.44
32	78.05	-.982	.190	+5.0	-4.91	+0.95	-10.5	+10.31	-2.00
33	80.49	-.941	.338	+4.2	-3.95	+1.42	-13.0	+12.23	-4.39
34	82.93	-.878	.478	+1.7	-1.49	+0.81	-13.0	+11.41	-6.21
35	85.37	-.795	.606	+1.8	-1.43	+1.09	-10.2	+8.11	-6.18
36	87.80	-.694	.720	-0.2	+.14	-0.14	-9.8	+6.80	-7.06
37	90.24	-.576	.817	+1.0	-.58	+0.82	-7.8	+4.49	-6.37
38	92.68	-.444	.896	+1.7	-.75	+1.52	-2.3	+1.02	-2.06
39	95.12	-.302	.953	+2.4	-.72	+2.29	+3.8	-1.15	+3.62
40	97.56	-.153	.988	+2.2	-.34	+2.17	+6.0	-.92	+5.93
41	100.00	-	1.000	+2.6	0	+2.60	+6.2	0	+6.20
			Total		-16.96 (A)	92.94 (B)		132.86 (A)	254.50 (B)

*Expressed as Percentages of 360°

#From Table I.

well. As in the case described above, the test depends on the relationship between the amplitude of the cycle fitted to the entire series under study and the expected amplitude as derived from the individual cycles fitted to the successive segments of the series.

It should be pointed out that the Bartels test assumes that genuine periodicities tend towards fixity in both period and amplitude. For, any variations, either systematic or random, in the length of the individual cycles tend to reduce the amplitude of the cycle curve fitted to the entire series through the averaging of out-of-phase ordinates, and so to reduce the final probability that the cycle is genuine. Likewise, variations in amplitude of individual cycles increase the expected average amplitude through the use of the quadratic mean, without proportionately increasing the amplitude of the overall cycle curve, and so also reduce the computed probability of genuineness. Hence, for comparability of results, it is generally advisable to express the series, as well as its time scale, if possible, in terms which stabilize to the fullest extent logically consistent with the nature of the series, the amplitude and period of the cycle under test. In this connection, it is usually not feasible to do much with the time scale, but often a change in the form of the series itself will tend to stabilize the cyclical amplitudes involved. For example, in the case used above in illustrating the significance test, the economic data were expressed as relatives to a long-term trend line in preference to absolute deviations, inasmuch as it resulted in a more stable cycle and also because it seemed the more reasonable approach. Had absolute deviations been used, the final probability would have been of the order of $\frac{1}{165}$.

November, 1944

TABLE III

TABULATION OF RESULTS OF HARMONIC ANALYSIS OF TWELVE SEGMENTS OF SERIES

Segment	A (From Table II)	B (From Table II)	$A^2 + B^2$
1	- 16.96	+ 92.94	8,925.49
2	- 11.05	+ 143.68	20,766.04
3	+ 308.14	- 29.18	95,801.73
4	+ 66.13	+ 70 25	9,308.24
5	+ 131.35	+ 115.42	30,574.60
6	+ 108.94	- 63.35	15,881.15
7	+ 236.80	+ 184.75	90,206.80
8	- 4.90	+ 110.45	12,223.21
9	- 24.97	+ 109.94	12,710 30
10	+ 321.10	+ 34.98	104,328.81
11	- 86.42	+ 79.24	13,747 39
12	+ 132.86	+ 254.50	82,422.03
Total	+1,161.02	+1,103.62	496,895.79
Average	+ 96.75	+ 91.97	41,407 98

AVERAGE AMPLITUDE $= \sqrt{96.75^2 + 91.97^2} = 133\ 49$

QUADRATIC MEAN OF TWELVE INDIVIDUAL AMPLITUDES = $\sqrt{41,407.98} = 203.49$

Footnotes

1 The values of sine and cosine used in Table II were taken from the trigonometric table shown in the Appendix. This table shows directly the values of sine Θ and cosine Θ for values of Θ expressed as percentages of 360°. It is particularly useful in harmonic analysis, as it eliminates the step of converting to degrees, minutes, and seconds, angles which are much more readily expressed in percentage form.

2 Chart I is essentially a "harmonic dial", differing from it only in using rectangular coordinates in place of polar. The construction of the chart is useful in illustrating the implications of the test and in presenting visually the results of the test, but, in practice, the final probabilities may be determined directly from the results computed as in Table III.

3 The distance $Op_1 = \sqrt{A_1^2 + B_1^2}$, and therefore does not equal the amplitude of the fitted sinusoid, but is a multiple of that amplitude. This amplitude "a_1" may be derived, if desired, from the equation $a_1 = \frac{2}{41}\sqrt{A_1^2 + B_1^2}$.

4 As an alternative approach, Bartels also assumes P to be the true point center, and computes the probability that the center of the twelve points could be as far from P as O is. As compared with the method outlined above, such an approach gives an even smaller probability that the cycle is of chance origin.

CHART I

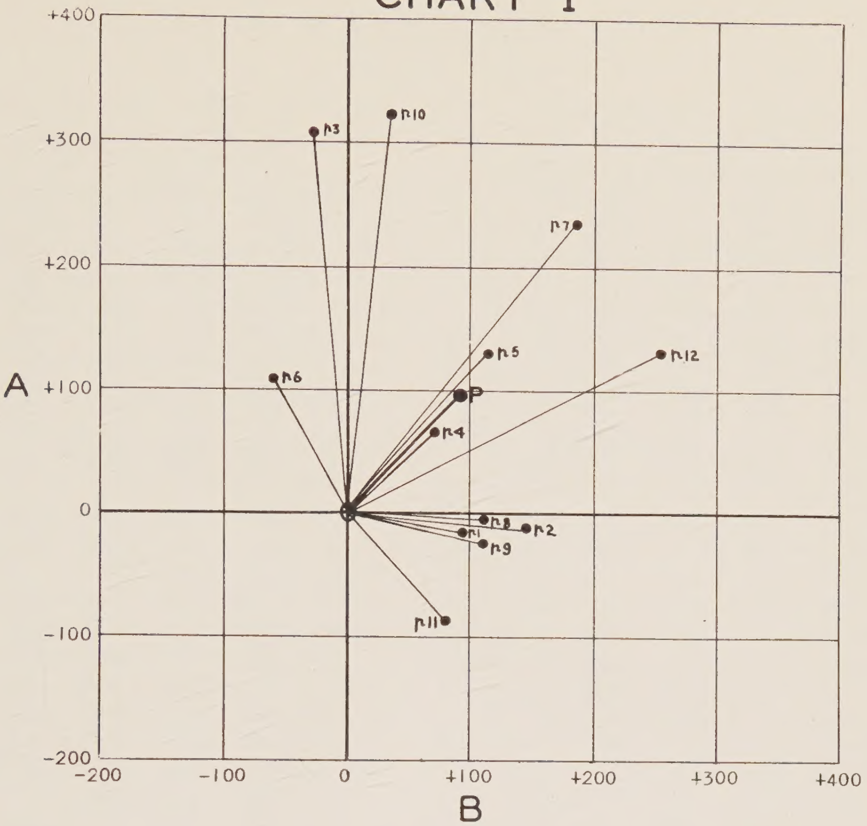

TABLE OF EXPONENTIALS

Values of e^n, From n = 1.0 to n = 10.9
(e = 2.71828)

n	.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	2.72	3.00	3.32	3.67	4.06	4.48	4.95	5.47	6.05	6.69
2	7.39	8.17	9.02	9.97	11.0	12.2	13.5	14.9	16.4	18.2
3	20.1	22.2	24.5	27.1	30.0	33.1	36.6	40.4	44.7	49.4
4	54.6	60.3	66.7	73.7	81.4	90.0	99.5	110	122	134
5	148	164	181	200	221	245	270	299	330	365
6	403	446	493	545	602	665	735	812	898	992
7	1097	1212	1339	1480	1636	1808	1998	2208	2441	2698
8	2981	3294	3639	4024	4447	4915	5431	6003	6635	7333
9	8103	8954	9894	10940	12090	13360	14760	16320	18040	19930
10	22030	24340	26890	29740	32860	36320	40130	44360	49030	54180

A TABLE OF SINES AND COSINES OF ANGLES
EXPRESSED AS PERCENTAGES OF PERIGONS

(360° = 100%)

Sin %	.0	.2	.4	.6	.8	Cos %
	(All Figures	Positive)				
0	0	.012	.025	.038	.050	75
1	.063	.075	.088	.100	.113	76
2	.125	.138	.150	.163	.175	77
3	.187	.200	.212	.224	.236	78
4	.249	.261	.273	.285	.297	79
5	.309	.321	.333	.345	.356	80
6	.368	.380	.391	.403	.414	81
7	.426	.437	.448	.460	.471	82
8	.482	.493	.504	.514	.525	83
9	.536	.546	.557	.567	.578	84
10	.588	.598	.608	.618	.628	85
11	.637	.647	.656	.666	.675	86
12	.684	.694	.702	.712	.720	87
13	.729	.737	.746	.754	.762	88
14	.770	.778	.786	.794	.802	89
15	.809	.816	.823	.831	.838	90
16	.844	.851	.857	.864	.870	91
17	.876	.882	.888	.894	.899	92
18	.905	.910	.915	.920	.925	93
19	.930	.934	.939	.943	.947	94
20	.951	.955	.958	.962	.965	95
21	.968	.972	.974	.977	.980	96
22	.982	.984	.987	.989	.990	97
23	.992	.994	.995	.996	.997	98
24	.998	.999	.999	1.000	1.000	99
25	1.000	1.000	1.000	.999	.999	0
26	.998	.997	.996	.995	.994	1
27	.992	.990	.989	.987	.984	2
28	.982	.980	.977	.974	.972	3
29	.968	.965	.962	.958	.955	4
30	.951	.947	.943	.939	.934	5
31	.930	.925	.920	.915	.910	6
32	.905	.899	.894	.888	.882	7
33	.876	.870	.864	.857	.851	8
34	.844	.838	.831	.823	.816	9
35	.809	.802	.794	.786	.778	10
36	.770	.762	.754	.746	.737	11
37	.729	.720	.712	.702	.694	12
38	.684	.675	.666	.656	.647	13
39	.637	.628	.618	.608	.598	14
40	.588	.578	.567	.557	.546	15
41	.536	.525	.514	.504	.493	16
42	.482	.471	.460	.448	.437	17
43	.426	.414	.403	.391	.380	18
44	.368	.356	.345	.333	.321	19
45	.309	.297	.285	.273	.261	20
46	.249	.236	.224	.212	.200	21
47	.187	.175	.163	.150	.138	22
48	.125	.113	.100	.088	.075	23
49	.063	.050	.038	.025	.012	24

Sin %	.0	.2	.4	.6	.8	Cos %
	(All Figures	Negative)				
50	0	.012	.025	.038	.050	25
51	.063	.075	.088	.100	.113	26
52	.125	.138	.150	.163	.175	27
53	.187	.200	.212	.224	.236	28
54	.249	.261	.273	.285	.297	29
55	.309	.321	.333	.345	.356	30
56	.368	.380	.391	.403	.414	31
57	.426	.437	.448	.460	.471	32
58	.482	.493	.504	.514	.525	33
59	.536	.546	.557	.567	.578	34
60	.588	.598	.608	.618	.628	35
61	.637	.647	.656	.666	.675	36
62	.684	.694	.702	.712	.720	37
63	.729	.737	.746	.754	.762	38
64	.770	.778	.786	.794	.802	39
65	.809	.816	.823	.831	.838	40
66	.844	.851	.857	.864	.870	41
67	.876	.882	.888	.894	.899	42
68	.905	.910	.915	.920	.925	43
69	.930	.934	.939	.943	.947	44
70	.951	.955	.958	.962	.965	45
71	.968	.972	.974	.977	.980	46
72	.982	.984	.987	.989	.990	47
73	.992	.994	.995	.996	.997	48
74	.998	.999	.999	1.000	1.000	49
75	1.000	1.000	1.000	.999	.999	50
76	.998	.997	.996	.995	.994	51
77	.992	.990	.989	.987	.984	52
78	.982	.980	.977	.974	.972	53
79	.968	.965	.962	.958	.955	54
80	.951	.947	.943	.939	.934	55
81	.930	.925	.920	.915	.910	56
82	.905	.899	.894	.888	.882	57
83	.876	.870	.864	.857	.851	58
84	.844	.838	.831	.823	.816	59
85	.809	.802	.794	.786	.778	60
86	.770	.762	.754	.746	.737	61
87	.729	.720	.712	.702	.694	62
88	.684	.675	.666	.656	.647	63
89	.637	.628	.618	.608	.598	64
90	.588	.578	.567	.557	.546	65
91	.536	.525	.514	.504	.493	66
92	.482	.471	.460	.448	.437	67
93	.426	.414	.403	.391	.380	68
94	.368	.356	.345	.333	.321	69
95	.309	.297	.285	.273	.261	70
96	.249	.236	.224	.212	.200	71
97	.187	.175	.163	.150	.138	72
98	.125	.113	.100	.088	.075	73
99	.063	.050	.038	.025	.012	74

C. E. ARMSTRONG

RESUME OF CYCLES-A MONTHLY REPORT

January 1952

The **Director's Letter** stresses that the Foundation is concerned with fact, not opinion.

The **Research** department contains six articles as follows:

1. "The 8-Year Cycle in Industrial Common Stocks." Industrial common stock prices act as if they were influenced by a cyclic force of about 8 1/6 years in length, or by two cyclic forces, one a little longer and the other a little shorter than this length.

2. "Cycles in Random Numbers." Cycles are easy to find in random numbers but, of course, they have no significance and do not continue after discovery.

3. "The 700-Year Cycle of the Climate and the Aurora Borealis" by Hideo Nishioka.

4. "The 37-Year Cycle in the Frequency of Chinese Earthquakes (since 200 A.D.)." Although there may be a cycle of 37.4 years in Chinese earthquakes as alleged by Clough, a cycle of 35.2 years has been much more important. If the 35.2-year cycle continues, the probabilities favor a more than usual number of earthquakes in the 20-year period centering on 1945.

5. "Some Neglected Aspects of Accident Prevention," by Rexford Hersey. Low periods in emotional cycles are an important factor in industrial accidents. Forty percent of all accidents in cases studied take place during the 10% intervals of cyclical lows.

6. "The 9-Year Cycle in Social Desease." The discovery of a 9-year cycle in social desease by Dr. Alvin Johnson once led to the overthrow of an important cause and effect hypothesis.

The **Technical Section** has an article entitled "The Use of Weighted Moving Averages in Cycle Analysis." This article describes weighted moving averages in general and lists 10 characteristics, important from the standpoint of cycle students, of a particular kind of weighted moving average called the section moving average or the moving periodic table.

The report ends with **Letters, Additions to the Library**, and a **Supplement** called "Cycles in the Sales and Advertising of the Pinkham Medicine Company—A Method for Evaluating Advertising and Predicting Sales" by Charles H. Pinkham.

February 1952

The **Director's Letter** discusses the forecast of Samuel Benner, made in 1875, which came true with a gain-loss ratio of 31 to 1 from the time it was made up to World War II.

The **Research** section contains three articles as follows:

1. "Cycles in the Stock Market." Although the forecasting of the ups and downs of the composite effect of all the cycles in the stock market is very difficult, if not impossible, in the present state of our knowledge of cycles, profit should be possible by using a knowledge of cycles to play the market on an actuarial basis.

2. "Cycles in Pig Iron Prices—Samuel Benner's Forecast of 1875." A forecast of pig iron prices made in 1875 by Samuel Benner, purely on the basis of inherent cycles, came true from the time it was made up to 1935 with a gain-loss ratio, based on imaginary trading, of 31 to 1.

By now, however, the forecast is probably out of step with reality, and cannot be depended upon for the future.

The task ahead is to revise the forecast so that it will hold good for the next 60 years as well as for the 60 years after it was made by Benner.

3. "Cycles in the Far East." A chart from a new book by H. Nishioka and T. Shiraishi showing fluctuations of various phenomena from the beginning of the first century to date.

The report concludes with **Foundation Affairs, Letters, Additions to the Library**, and a **Supplement** consisting of excerpts from Samuel Benner's book, **Benner's Prophecies of Future Ups and Downs in Prices.**